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A Public Choice Approach to Transboundary Acid Deposition

By

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ABSTRACT

This paper applies public choice theory to the problem of transboundary-transported air pollution. Conventional theoretical wisdom dealing with external diseconomics is insufficient for problems of this nature. The process of issue linkage is suggested for a mutually advantageous agreement in the presence of otherwise highly skewed benefits.

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Introduction

If one defines public choice as the aggregation of individual preferences to maximize a social welfare function, public choice theories come to play in the presence of a market imperfection. It was a collective decision which created the market mechanism; we rely on implicit social choice to sustain its existence; thus, it is reasonable to presume that a collective action may be required to correct the imperfection. Mueller [1976] points out that the work on public choice in the presence of market failure centers on establishing the conditions for an efficient allocation of resources once an imperfection has been identified. Hardin [1982] introduces the problems of public choice when dealing with the pollution externality by labeling the idea as logically impeccable, yet seemingly specious.

This paper focuses on the interaction of individual actors in arriving at a solution to the transboundary-transported air pollution problem. First, a brief discussion is provided on the problem of transported air pollution and the familiar theoretical solutions to such a phenomenon. Then, the complexities introduced by trans-boundary pollution are presented, followed by a discussion of how this dilemma can be addressed through collective action. The paper concludes with a suggested research agenda.

The Problem of Transported Air Pollution

The transported pollution presently receiving the most attention is acid precipitation. It has become a political as well as scientific issue in many areas of the world. This phenomenon is the source of tension between Great Britain, Germany, and Scandinavia; between China and Korea;

between the United States and Canada; and even between different regions of the United States. All of this has increased the public awareness of the problem and the call for some type of political action. The main concern about acid rain is the cumlative ecosystem and structural damage it causes in any region on which it falls. The main sources and receptors are shown below.

Acid Rain

Sources	Receptors
- Coal burning Plants	- Agricultural crops
- Transportation Vehicles	- Forests
- Other Power Facilities	- Aquatic systems
- Natural Sources (volcanoes, sulfur emissions from seas and soils)	- Structures and Buildings

The U.S. Environmental Protection Agency estimates that as much as 50 percent of total global SO_x emissions come from economic activities including 14 percent from petroleum refining, 16 percent from burning petroleum products, and 70 percent from coal combustion.[1]

With any technological external diseconomy[2], the true cost of producing the good or service is shared by (imposed on) entities outside the market for that good. The price of electricity in one region is lower than its true economic cost because part of the cost is borne by members of another region. Externalities of this type create an imperfection in the market, or a divergence between private and social costs and benefits. This results in a misallocation of resources from an economic efficiency standpoint. The methods employed to correct this imperfection will vary, depending on the circumstances encountered.

Simple Theoretical Solution

Consider a source-receptor situation where the source is a fertilizer processing plant and the receptor is a neighborhood of 15 residential homes downwind. The location of this plant imposes a cost on the neighborhood residents by degrading the quality of the air. Since the price paid by the fertilizer customers does not reflect the cost imposed on the neighborhood, the conditions for social efficiency are violated by the economic activities of various entities [Mills, 1978]. In this case, it is possible to make some people better off without making anyone worse off, i.e., it is not a Parento optimal allocation of resources. Therefore, those who stand to gain from a correction in this situation have the incentive to seek each other and negotiate a collectively advantageous agreement. The neighborhood may form an association designed to confront the fertilizer plant, seeking a resolution of the problem.

If we let D represent the total annual damages to the receptors and C be the cost of abatement, a situation where D > C would indicate that a mutually advantageous agreement could be reached. Several possible solutions are outlined by Bromley [1978] in his discussion of alternative rules of entitlements. The association would be willing to pay the fertilizer plant an amount between C and D to entice the abatement of pollution. Or, conversely, the association would be willing to allow the plant to continue its pollution if it paid them an amount greater than or equal to D. In each case, property rights are not explicitly assigned, yet one or the other is protected by a liability rule (a right to compensation). The two senarios would probably not result in the same allocation of resources, as the incomes or profits of each party would be affected by the outcome. In essence, the decision reached through private negotiation regards the assignment of entitlements. In the first solution, the firm apparently had the right to pollute and could be stopped only through compensation. In the other case, the association had the right to clean air which could be violated if they are recompensed.

As simple and intuitively pleasing as this example is, market inefficiencies caused by pollution are normally not corrected in such a manner. This is true for two reasons: (1) transaction costs, and (2) the public good nature of pollution abatement.

First, transaction costs include the costs of congregating the receptors, locating the sources, and negotiating a mutually agreeable exchange [Mills, 1978]. When speaking of a small neighborhood of receptors affected by one source, the chances are good that the individuals could successfully gather to confront the problem in a manner similar to what was presented above. However, when we consider a large number of geographically and politically separated receptors affected by a large number of geographically separated sources, the problem of collecting individuals becomes more complex; and, the costs involved to congregate these individuals for the purpose of reaching a decision may prove prohibitive.

In order to fully understand the foregoing, consider the response function cited in Mueller, $R = BP + d - c$, where BP represents the perceived benefit to society from an individual action (B) multiplied by the perceived probability that this individual action will have an effect on the outcome (P); and $d - c$ represents the individual's private benefit minus the private cost of action. For a small group, BP may dominate the decision of the individual since it is perceived that an extra person will make a big difference in the outcome with a high probability. As the size of the group increases, the perceived group benefit of an individual's action is reduced, as is the perception of P. At this point the d - c components dominate, and the individual responds based on private net benefit. Buchanan and Tullock [1969] show how the individual costs of decision making increase with group size. Assuming this is the case, the individuals will soon find such action resulting in a negative net benefit, which will result in nonparticipation. It follows that the costs of securing agreement, within a decisionmaking group, increase as the size of the group increases [Buchanan and Tullock]. At some point, the "transactions cost" of gathering the receptors to make a collective decision is greater than the benefits derived. This is especially true when dealing with multiple sources as well as a large number of receptors.

Next, consider the public good characteristics of pollution abatement. Remember that a pure public good satisfies three conditions: (1) absence of rivalry among beneficiaries, (2) it is not possible and/or feasible to exclude one beneficiary, and (3) adding one beneficiary carries zero marginal cost. Once a pollution abatement program has been implemented, excluding one beneficiary is not possible. Also, consumption or enjoyment of this good by one individual does not preclude or decrease the enjoyment by others; and, adding one more beneficiary adds nothing to the total cost of the control program. The public good nature of pollution abatement circumvents private negotiation through the phenomenon of the free rider. Because we are dealing with a public good, all receptors will benefit from the abatement program, regardless of whether they contribute. If total societal benefits equal D, contributions may sum to D - D/N in the presence of one free rider. Consequently, even though D is greater than C, the pollution abatement program would not function properly.

Due to the problems discussed above it may be concluded that pollution abatement cannot be adequately handled through private negotiation. Since it may be characterized as a public good, it requires policymaking and implementation via some collective action or government process.

The Transboundary Problem

Consider the situation where the source-receptor relationship spans two geographic regions or political jurisdictions, the typical case with transported pollution. This means that the consumption of individuals in one region imposes spillover effects on individuals in another jurisdiction. Even though the source and receptor are geographically separated, the pollution still results in a social inefficiency. However, it is difficult for the residents of the source region to realize the need for corrective action, or for the residents of the receptor region to realize either source reductions or compensation for damage.

The source and receptor will not arrive at a solution through private negotiation for the reasons stated earlier. Thus, some type of collective action is required if progress is to be made. National governments have administrative, legislative, and judicial mechanisms for "internalizing" actions whose effects cross regional or state boundaries; but, what about economic activities whose effects transcend national boundaries?

Mills writes of caring for the "global environment" where our accounting stance changes to confront the resource allocation problem from a worldwide perspective. However, Frey [1984] points out, in international politics, even when the actors fully perceive that it is advantageous for them to cooperate in the provision of a public good, it is difficult and sometimes even impossible to coordinate joint action. Some type of constitutional contract may be arranged between the independent national actors;

however, cooperation cannot be guaranteed unless the actors believe that obeying the rules will be mutually advantageous.

In addition, the contractual relationship should involve as few member nations as possible. Empirical studies have shown small state, regional, or international organizations to be more successful at achieving their objectives than their larger counterparts [Russell, 1971]. This is because each nation sees its additional cost of contribution rising steeply as the organization grows in size and activity. In addition, the perceived marginal benefit declines with growth, and the individual actor finds it increasingly difficult to take interest and devote effort. This observed phenomenon can be explained by the response function discussed earlier.[3/] Thus, any contractual agreement designed to alleviate or compensate for trans-boundary acid deposition must involve a small number of nations who individually perceive it to be mutually advantageous to cooperate.

Mutual Compensation Agreement

A plan which incorporates the aforementioned features is the mutual compensation agreement presented by the OECD [1976] as a framework for solving the problems of trans-boundary pollution. It features acceptable characteristics by the simple standards set out above; however, it does not address all the difficulties inherent in a joint nation agreement. The framework assumes one way transported pollution where the source nation (source) and receptor nation (receptor) are able to agree that action is needed to resolve the situation.

The mutual compensation rule requires the source to pay an emissions tax related to the cost of transboundary damages estimated by the receptor, while the receptor pays an abatement fee based on the cost of pollution control as estimated by the source. In essence, this scheme induces the source to reduce its emissions and encourages the receptor to accept some of the residual costs. If the receptor requires more intensive abatement, it must compensate by paying a higher fee; likewise, the source can emit more pollutants only by paying more tax. The policies will be established and implemented by a joint agency consisting of representatives from each nation. The joint agency will determine the charges to the source and receptor as well as the appropriate compensation based on the information provided by each actor.

The analysis begins with an estimation of the damages to the receptor from trans-boundary deposition, as estimated by the receptor:[4/]

$$D = \delta D(p) + d \qquad (1)$$

which states that estimated damage is a function of the pollution level, p, the administrative cost of estimating the function, d, and an error term δ.

Likewise, the cost of abatement, as estimated by the source, is expressed as

$$C = \alpha C(p) + a \qquad (2)$$

with a similar interpretation. The joint agency uses this information to determine the optimal level of emissions by minimizing the total amount collected from the two nations,

$$M = \alpha C(p) + a + \delta D(p) + d; \qquad (3)$$

then it determines the appropriate compensation for each actor. By minimizing M and solving for first and second order conditions, it can be shown that the interaction of the source, receptor, and joint agency will lead to an optimal level of pollution p*, and very accurate estimates of the damages and costs, i.e., $\delta = \alpha = 1$.[5/]

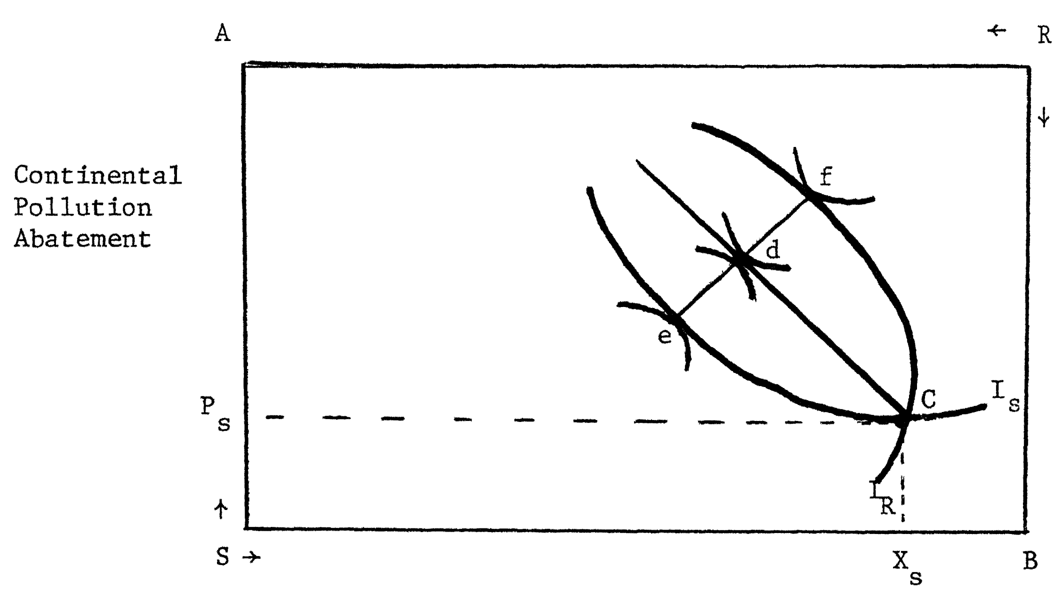
There are advantages and disadvantages to this framework. First, mutual compensation is based on economic theory and results in an efficient solution between the two actors, i.e., each nation desires the pollution where the tax paid reflects their marginal willingness to pay. However, although this principle leads to an efficient level of pollution, it does not result in an optimal resource allocation. To see this, apply the mutual compensation solution to the fertilizer plant example. The plant pays the association an amount D; the association pays the plant an amount C; and emissions are reduced. Assuming the pollution level P* is efficiently determined, the price of fertilizer facing the consumer is unaffected. If the receptors are not the consumers of fertilizer, we continue to suffer a social inefficiency since the price still does not reflect the true cost.

Another advantage of mutual compensation is that it discourages error or cheating on the part of either nation; and it provides a forum for the exchange of technical information which each party will provide to improve the administrative efficiency of the system. However, this system would be very costly to administer as well as police.

Finally, mutual compensation provides a means of one-to-one negotiation which is crucial for alleviation of the transboundary pollution problem. This assumes that encouraging negotiations are well underway with each party searching for some solution to the transboundary pollution problem. This is not always the case. As stated earlier, the source is not likely to see adequate reason to move from status quo if it can not be shown that doing so will improve its position. Although mutual compensation is an efficient method of handling the problem of trans-boundary externalities, it fails to address the situation where the benefits of entering into such an agreement are strongly skewed toward one nation. Sampson [1982] states that if the present situation fails the test for international policy coordination, then there is a basis for adding and subtracting of issues to see if alternative situations place parties in a position to bargain.

Issue Linkage and Transboundary Pollution

Tollison and Willett [1979] developed the idea of using issue linkages as a means of paying compensation through positions taken in other negotiations. They contend that linkage of issues is most likely to prove successful where the benefits of negotiation are skewed in the direction of a few bargainers. Thus, issue linkage is a way to encourage discussions which may not otherwise occur due to distributional effects. The Tollison-Willett analysis is applied to the source-receptor transboundary pollution problem in the illustration below. This shows a graphical depiction of negotiations proceeding between two nations (e.g., U.S. and Canada) involving expendi-



Continental Potash Imports

tures and assumed responsibility regarding two issues of continental interest: potash imports and acid pollution abatement. Read the source's (S) indifference curve from the southwest corner and the receptor's (R) indifference curve from the northeast corner. If the present state of affairs places the two countries at point C in their negotiations, one sees the source responsible for SX_s of potash imports and SP_s of pollution control. Movement along cd places both countries on higher indifference curves. At point d the source and receptor have exhausted all gains from agreement. Curve ef is the contract curve along which movement is possible only by superior bargaining of one or the other actor. For instance, point f places s at a much better position at the expense of R, i.e., zero sum exchange.

As is illustrated in this example, the bargaining begins between S and R at a point where both can gain through informed negotiation. In this situation, the source would be willing to take a more active role in reducing air pollution if the receptor would reduce or not impose barriers to potash exports. Agreements such as this move them along cd to higher levels of total welfare. This implies that, for some cases, the best alternative is to find another area of possible exchange which has highly skewed benefits. Linking those issues would allow both parties to find advantages in negotiations, thus an agreement would increase the welfare of all parties involved.

In summary, this paper has delineated the collective good nature of acid deposition and has discussed two alternatives (mutual compensation and issue linkage) for handling same. This provides a framework for defining the proper accounting stance and getting estimates of economic social costs and benefits from varying levels of acid deposition. For example, under the mutual compensation agreement estimates of damage to aquatic systems by scientists in Canada would form a partial basis for an emissions tax on U.S. coal fired power plants. Scientists from the U.S. would in turn estimate the cost of power plant pollution control to form a partial basis for an abatement fee for Canada.

If the benefits of entering the foregoing agreement are strongly skewed to one nation (e.g., Canada) the issue linkage alternative provides some empirical direction. The U.S. is dependent on Canada for 85 percent of its potash consumption and analysis could focus on an optimal tariff on potash exports, i.e., where the marginal revenues from a proposed Canada tariff equal the marginal cost of U.S. emission control. Additional analysis of the public choice links between electric power generation and potash conversion in agricultural production would also be required.

Footnotes

1. U.S. Environmental Protection Agency, Office of Research and Development, "Acid Rain," EPA - 600/79-036, 1980.

2. Physical interdependence of production and/or consumption functions which is not fully priced or compensated.

3. Where R = PB - c + d, the PB declines sharply and the c rises which reduces R.

4. OECD Cooperative Technical Program to Measure the Long-Range Transport of Air Pollutants has developed computer models capable of estimating foreign contributions to each member country's sulfur deposition.

5. For a thorough mathematical and graphical presentation of this point, see OECD, pages 133-136.

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